



Full wwPDB NMR Structure Validation Report ⓘ

Mar 8, 2026 – 12:49 PM UTC

PDB ID : 1S2H / pdb_00001s2h
Title : The Mad2 spindle checkpoint protein possesses two distinct natively folded states
Authors : Luo, X.; Tang, Z.; Xia, G.; Wassmann, K.; Matsumoto, T.; Rizo, J.; Yu, H.
Deposited on : 2004-01-08

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We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<https://www.wwpdb.org/validation/2017/NMRValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity	:	4-5-2 with Phenix2.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
wwPDB-RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
wwPDB-ShiftChecker	:	v1.2
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

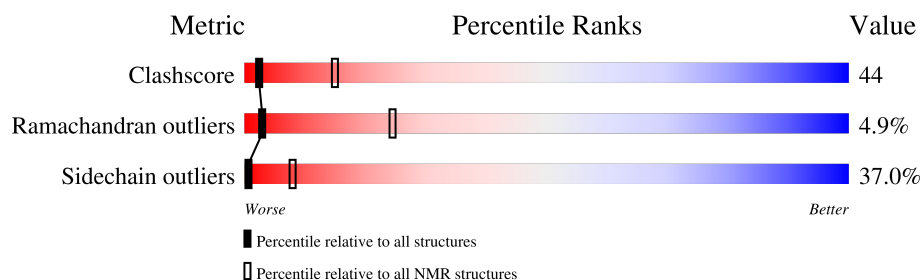
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

SOLUTION NMR

The overall completeness of chemical shifts assignment was not calculated.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	NMR archive (#Entries)
Clashscore	229148	14424
Ramachandran outliers	224038	12848
Sidechain outliers	223484	12823

The table below summarises the geometric issues observed across the polymeric chains and their fit to the experimental data. The red, orange, yellow and green segments indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. A cyan segment indicates the fraction of residues that are not part of the well-defined cores, and a grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions $\leq 5\%$

Mol	Chain	Length	Quality of chain
1	A	206	36% 39% 24%

2 Ensemble composition and analysis ⓘ

This entry contains 1 models. Identification of well-defined residues and clustering analysis are not possible.

3 Entry composition

There is only 1 type of molecule in this entry. The entry contains 3320 atoms, of which 1670 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Mitotic spindle assembly checkpoint protein MAD2A.

Mol	Chain	Residues	Atoms						Trace
1	A	205	Total	C	H	N	O	S	0
			3320	1056	1670	268	321	5	

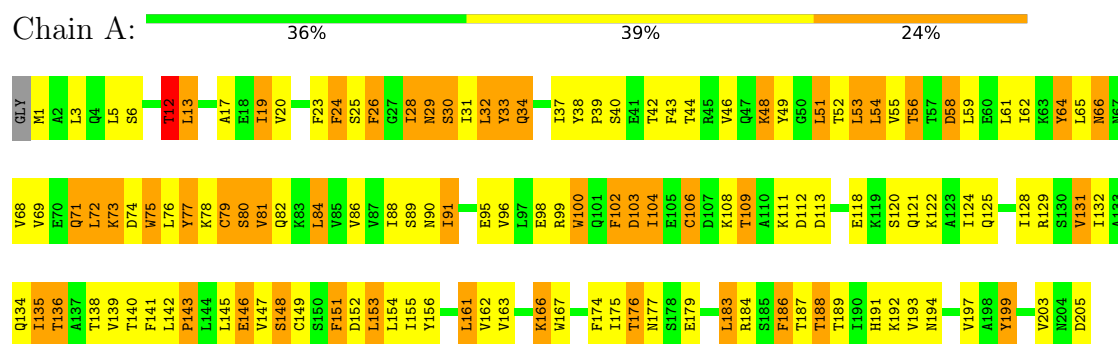
There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	0	GLY	-	cloning artifact	UNP Q13257
A	133	ALA	ARG	engineered mutation	UNP Q13257

4 Residue-property plots

These plots are provided for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic is the same as shown in the summary in section 1 of this report. The second graphic shows the sequence where residues are colour-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. Stretches of 2 or more consecutive residues without any outliers are shown as green connectors. Residues which are classified as ill-defined in the NMR ensemble, are shown in cyan with an underline colour-coded according to the previous scheme. Residues which were present in the experimental sample, but not modelled in the final structure are shown in grey.

- Molecule 1: Mitotic spindle assembly checkpoint protein MAD2A



5 Refinement protocol and experimental data overview ⓘ

The models were refined using the following method: *torsion angle dynamics*.

Of the 500 calculated structures, 1 were deposited, based on the following criterion: *structures with the lowest energy*.

The following table shows the software used for structure solution, optimisation and refinement.

Software name	Classification	Version
CNS	refinement	1.0

No chemical shift data was provided.

6 Model quality

6.1 Standard geometry

There are no covalent bond-length or bond-angle outliers.

There are no bond-length outliers.

There are no bond-angle outliers.

There are no chirality outliers.

There are no planarity outliers.

6.2 Too-close contacts

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in each chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes averaged over the ensemble.

Mol	Chain	Non-H	H(model)	H(added)	Clashes
1	A	1650	1670	1671	146
All	All	1650	1670	1671	146

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 44.

All clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)
1:A:124:ILE:O	1:A:128:ILE:HG22	0.91	1.66
1:A:17:ALA:HB2	1:A:77:TYR:CE2	0.84	2.08
1:A:142:LEU:HD21	1:A:199:TYR:CD2	0.81	2.10
1:A:17:ALA:HB2	1:A:77:TYR:CZ	0.81	2.11
1:A:33:TYR:CD2	1:A:43:PHE:CE2	0.80	2.70
1:A:26:PHE:CE1	1:A:53:LEU:HD12	0.79	2.12
1:A:32:LEU:HD11	1:A:61:LEU:CD1	0.79	2.06
1:A:135:ILE:O	1:A:139:VAL:HG23	0.77	1.77
1:A:51:LEU:HD13	1:A:53:LEU:HD21	0.76	1.56
1:A:103:ASP:C	1:A:104:ILE:HD12	0.76	2.05
1:A:32:LEU:HD11	1:A:61:LEU:HD13	0.73	1.61
1:A:64:TYR:O	1:A:68:VAL:HG23	0.71	1.85
1:A:72:LEU:HG	1:A:76:LEU:HD12	0.69	1.64
1:A:76:LEU:HD22	1:A:81:VAL:HA	0.68	1.66
1:A:65:LEU:O	1:A:69:VAL:HG23	0.68	1.88

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Atom-1	Atom-2	Clash(Å)	Distance(Å)
1:A:71:GLN:O	1:A:75:TRP:N	0.66	2.28
1:A:134:GLN:OE1	1:A:183:LEU:HD13	0.66	1.89
1:A:90:ASN:ND2	1:A:147:VAL:HG11	0.66	2.05
1:A:175:ILE:HG22	1:A:176:THR:HG22	0.66	1.65
1:A:76:LEU:HD13	1:A:81:VAL:HG13	0.65	1.68
1:A:53:LEU:HB3	1:A:132:ILE:HD13	0.65	1.67
1:A:91:ILE:HB	1:A:148:SER:O	0.64	1.92
1:A:76:LEU:HB3	1:A:81:VAL:HG22	0.64	1.70
1:A:52:THR:C	1:A:53:LEU:HD23	0.63	2.19
1:A:53:LEU:HD13	1:A:132:ILE:CD1	0.63	2.23
1:A:75:TRP:C	1:A:75:TRP:CD1	0.62	2.78
1:A:26:PHE:CD1	1:A:53:LEU:HD12	0.62	2.30
1:A:24:PHE:CE2	1:A:28:ILE:CD1	0.62	2.83
1:A:20:VAL:HG21	1:A:106:CYS:SG	0.61	2.36
1:A:24:PHE:CE2	1:A:28:ILE:HD11	0.61	2.30
1:A:104:ILE:HD12	1:A:104:ILE:N	0.60	2.11
1:A:100:TRP:CZ2	1:A:135:ILE:HG12	0.60	2.31
1:A:147:VAL:HG23	1:A:149:CYS:SG	0.60	2.37
1:A:33:TYR:C	1:A:33:TYR:CD1	0.60	2.80
1:A:51:LEU:H	1:A:51:LEU:HD12	0.59	1.57
1:A:64:TYR:OH	1:A:153:LEU:HD21	0.59	1.96
1:A:51:LEU:HD12	1:A:51:LEU:N	0.59	2.13
1:A:31:ILE:HG12	1:A:135:ILE:HG21	0.58	1.74
1:A:33:TYR:CE2	1:A:43:PHE:CE2	0.58	2.90
1:A:30:SER:OG	1:A:132:ILE:HG23	0.57	1.98
1:A:43:PHE:HB3	1:A:54:LEU:HD23	0.57	1.76
1:A:33:TYR:CD2	1:A:54:LEU:HD22	0.56	2.34
1:A:64:TYR:CD1	1:A:64:TYR:C	0.56	2.83
1:A:33:TYR:CG	1:A:43:PHE:CE2	0.56	2.94
1:A:43:PHE:HB3	1:A:54:LEU:CD2	0.56	2.31
1:A:53:LEU:HD13	1:A:132:ILE:HD11	0.54	1.77
1:A:33:TYR:C	1:A:33:TYR:HD1	0.54	2.09
1:A:24:PHE:CD1	1:A:25:SER:N	0.54	2.75
1:A:79:CYS:O	1:A:80:SER:CB	0.54	2.56
1:A:38:TYR:HB2	1:A:39:PRO:HD2	0.53	1.79
1:A:86:VAL:HG23	1:A:102:PHE:CE1	0.53	2.38
1:A:132:ILE:HA	1:A:135:ILE:HD12	0.53	1.80
1:A:131:VAL:O	1:A:135:ILE:HG13	0.53	2.04
1:A:32:LEU:HD11	1:A:61:LEU:HD11	0.53	1.79
1:A:32:LEU:CD1	1:A:61:LEU:HD13	0.52	2.32
1:A:34:GLN:HG3	1:A:136:THR:HA	0.52	1.80
1:A:19:ILE:HG22	1:A:20:VAL:N	0.52	2.20

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Atom-1	Atom-2	Clash(Å)	Distance(Å)
1:A:64:TYR:CE1	1:A:65:LEU:HD23	0.52	2.40
1:A:40:SER:HA	1:A:43:PHE:CE1	0.51	2.39
1:A:51:LEU:N	1:A:51:LEU:CD1	0.51	2.73
1:A:76:LEU:HD11	1:A:155:ILE:HG23	0.51	1.83
1:A:12:THR:HG22	1:A:109:THR:CG2	0.51	2.36
1:A:64:TYR:CZ	1:A:65:LEU:CD2	0.51	2.93
1:A:64:TYR:CE1	1:A:153:LEU:HD13	0.51	2.41
1:A:48:LYS:O	1:A:51:LEU:CD1	0.51	2.59
1:A:131:VAL:O	1:A:134:GLN:HG2	0.51	2.06
1:A:103:ASP:O	1:A:193:VAL:HG13	0.50	2.07
1:A:121:GLN:O	1:A:124:ILE:HB	0.50	2.06
1:A:156:TYR:CE1	1:A:167:TRP:CD1	0.50	2.99
1:A:33:TYR:CG	1:A:43:PHE:CZ	0.49	3.00
1:A:64:TYR:CZ	1:A:65:LEU:HD21	0.49	2.43
1:A:73:LYS:O	1:A:77:TYR:CB	0.49	2.61
1:A:19:ILE:O	1:A:23:PHE:HB2	0.49	2.07
1:A:33:TYR:CE2	1:A:54:LEU:HD22	0.49	2.43
1:A:5:LEU:HD23	1:A:6:SER:N	0.49	2.23
1:A:183:LEU:HD11	1:A:197:VAL:HG12	0.49	1.84
1:A:162:VAL:O	1:A:162:VAL:HG12	0.49	2.07
1:A:38:TYR:CE2	1:A:42:THR:OG1	0.48	2.65
1:A:73:LYS:O	1:A:77:TYR:HB2	0.48	2.07
1:A:34:GLN:CB	1:A:135:ILE:HG22	0.48	2.38
1:A:86:VAL:HG23	1:A:102:PHE:CZ	0.48	2.43
1:A:24:PHE:CZ	1:A:65:LEU:HD22	0.48	2.43
1:A:142:LEU:HD21	1:A:199:TYR:CE2	0.48	2.42
1:A:13:LEU:HD23	1:A:108:LYS:HA	0.47	1.87
1:A:68:VAL:HG12	1:A:72:LEU:HD13	0.47	1.86
1:A:86:VAL:HA	1:A:152:ASP:O	0.47	2.10
1:A:43:PHE:CD2	1:A:54:LEU:HD22	0.47	2.45
1:A:44:THR:HG23	1:A:55:VAL:HB	0.47	1.85
1:A:31:ILE:CD1	1:A:100:TRP:CD2	0.46	2.98
1:A:24:PHE:CD1	1:A:24:PHE:C	0.46	2.93
1:A:34:GLN:CB	1:A:139:VAL:HG21	0.46	2.40
1:A:24:PHE:CE1	1:A:65:LEU:HD22	0.46	2.46
1:A:32:LEU:HD12	1:A:38:TYR:HE1	0.46	1.71
1:A:48:LYS:HB3	1:A:49:TYR:CD1	0.46	2.46
1:A:51:LEU:H	1:A:51:LEU:CD1	0.46	2.24
1:A:71:GLN:O	1:A:75:TRP:HB3	0.46	2.11
1:A:102:PHE:N	1:A:102:PHE:CD1	0.46	2.83
1:A:186:PHE:HE1	1:A:193:VAL:HG23	0.46	1.71
1:A:32:LEU:HD21	1:A:151:PHE:CZ	0.46	2.45

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Atom-1	Atom-2	Clash(Å)	Distance(Å)
1:A:26:PHE:CZ	1:A:53:LEU:HD12	0.45	2.46
1:A:51:LEU:HD21	1:A:129:ARG:HA	0.45	1.88
1:A:174:PHE:N	1:A:174:PHE:CD1	0.45	2.83
1:A:29:ASN:OD1	1:A:55:VAL:HG12	0.45	2.11
1:A:38:TYR:CE2	1:A:58:ASP:OD1	0.45	2.70
1:A:43:PHE:CD2	1:A:54:LEU:CD2	0.45	2.99
1:A:104:ILE:N	1:A:104:ILE:CD1	0.45	2.79
1:A:187:THR:HG23	1:A:192:LYS:HG3	0.45	1.88
1:A:100:TRP:CH2	1:A:135:ILE:HG12	0.45	2.47
1:A:51:LEU:HD13	1:A:53:LEU:CD2	0.45	2.38
1:A:62:ILE:O	1:A:66:ASN:HB2	0.45	2.11
1:A:199:TYR:CD1	1:A:199:TYR:N	0.44	2.83
1:A:19:ILE:HD12	1:A:124:ILE:HG21	0.44	1.88
1:A:64:TYR:CE1	1:A:65:LEU:CD2	0.44	3.00
1:A:38:TYR:OH	1:A:56:THR:CG2	0.44	2.66
1:A:186:PHE:CZ	1:A:188:THR:OG1	0.44	2.71
1:A:96:VAL:HB	1:A:175:ILE:HG23	0.43	1.88
1:A:132:ILE:O	1:A:136:THR:OG1	0.43	2.36
1:A:138:THR:O	1:A:142:LEU:N	0.43	2.52
1:A:33:TYR:HD1	1:A:33:TYR:O	0.42	1.96
1:A:58:ASP:O	1:A:62:ILE:CG1	0.42	2.67
1:A:145:LEU:HG	1:A:146:GLU:N	0.42	2.29
1:A:58:ASP:O	1:A:62:ILE:HD12	0.42	2.14
1:A:38:TYR:CE2	1:A:58:ASP:CG	0.42	2.96
1:A:40:SER:CB	1:A:43:PHE:CZ	0.42	3.03
1:A:72:LEU:O	1:A:76:LEU:CB	0.42	2.67
1:A:128:ILE:HD11	1:A:132:ILE:HD11	0.42	1.91
1:A:31:ILE:HD11	1:A:100:TRP:CE3	0.42	2.50
1:A:32:LEU:HD21	1:A:151:PHE:CE2	0.42	2.50
1:A:44:THR:N	1:A:55:VAL:O	0.42	2.52
1:A:43:PHE:HA	1:A:55:VAL:O	0.42	2.15
1:A:141:PHE:HE2	1:A:199:TYR:CE2	0.41	2.32
1:A:40:SER:C	1:A:42:THR:N	0.41	2.78
1:A:82:GLN:O	1:A:104:ILE:N	0.41	2.49
1:A:89:SER:O	1:A:149:CYS:HB3	0.41	2.15
1:A:64:TYR:CE1	1:A:153:LEU:CD1	0.41	3.03
1:A:38:TYR:CZ	1:A:58:ASP:CG	0.40	2.99
1:A:68:VAL:O	1:A:72:LEU:HB2	0.40	2.17
1:A:100:TRP:NE1	1:A:197:VAL:HG21	0.40	2.32
1:A:125:GLN:HA	1:A:128:ILE:CG2	0.40	2.47
1:A:19:ILE:CG2	1:A:20:VAL:N	0.40	2.83
1:A:75:TRP:CZ2	1:A:155:ILE:HG13	0.40	2.51

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Atom-1	Atom-2	Clash(Å)	Distance(Å)
1:A:88:ILE:CG2	1:A:149:CYS:CB	0.40	2.99
1:A:186:PHE:CE2	1:A:188:THR:OG1	0.40	2.74
1:A:84:LEU:HB2	1:A:104:ILE:HD13	0.40	1.93
1:A:72:LEU:O	1:A:76:LEU:HB2	0.40	2.16
1:A:142:LEU:HB3	1:A:143:PRO:HD2	0.40	1.93

6.3 Torsion angles [i](#)

6.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all PDB entries followed by that with respect to all NMR entries. The Analysed column shows the number of residues for which the backbone conformation was analysed and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	203/206 (99%)	172 (85%)	21 (10%)	10 (5%)	3	24
All	All	203/206 (99%)	172 (85%)	21 (10%)	10 (5%)	3	24

All 10 Ramachandran outliers are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type
1	A	12	THR
1	A	80	SER
1	A	81	VAL
1	A	112	ASP
1	A	143	PRO
1	A	161	LEU
1	A	163	VAL
1	A	166	LYS
1	A	176	THR
1	A	203	VAL

6.3.2 Protein sidechains [i](#)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all PDB entries followed by that with respect to all NMR entries. The Analysed column shows the number of residues for which the sidechain conformation was analysed and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	189/189 (100%)	119 (63%)	70 (37%)	1	8
All	All	189/189 (100%)	119 (63%)	70 (37%)	1	8

All 70 residues with a non-rotameric sidechain are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type
1	A	1	MET
1	A	3	LEU
1	A	12	THR
1	A	13	LEU
1	A	19	ILE
1	A	24	PHE
1	A	26	PHE
1	A	28	ILE
1	A	29	ASN
1	A	30	SER
1	A	32	LEU
1	A	33	TYR
1	A	34	GLN
1	A	37	ILE
1	A	46	VAL
1	A	48	LYS
1	A	51	LEU
1	A	53	LEU
1	A	54	LEU
1	A	56	THR
1	A	58	ASP
1	A	59	LEU
1	A	64	TYR
1	A	66	ASN
1	A	71	GLN
1	A	72	LEU
1	A	73	LYS
1	A	74	ASP
1	A	75	TRP
1	A	77	TYR
1	A	78	LYS
1	A	79	CYS
1	A	84	LEU
1	A	91	ILE
1	A	95	GLU
1	A	98	GLU

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Mol	Chain	Res	Type
1	A	99	ARG
1	A	100	TRP
1	A	102	PHE
1	A	103	ASP
1	A	104	ILE
1	A	106	CYS
1	A	109	THR
1	A	111	LYS
1	A	113	ASP
1	A	118	GLU
1	A	120	SER
1	A	122	LYS
1	A	131	VAL
1	A	135	ILE
1	A	136	THR
1	A	140	THR
1	A	146	GLU
1	A	148	SER
1	A	151	PHE
1	A	153	LEU
1	A	154	LEU
1	A	161	LEU
1	A	166	LYS
1	A	177	ASN
1	A	179	GLU
1	A	183	LEU
1	A	184	ARG
1	A	186	PHE
1	A	188	THR
1	A	189	THR
1	A	191	HIS
1	A	194	ASN
1	A	199	TYR
1	A	205	ASP

6.3.3 RNA ⓘ

There are no RNA molecules in this entry.

6.4 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

6.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

6.6 Ligand geometry [i](#)

There are no ligands in this entry.

6.7 Other polymers [i](#)

There are no such molecules in this entry.

6.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

7 Chemical shift validation

No chemical shift data were provided